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I also certify that the attached copy of the request for grant of a Patent (Form 1/77) bears an amendment, effected by this office, following a request by the applicant and agreed to by the Comptroller-General.

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Signed

Dated 17 June 2003

GB0212553.2

By virtue of a direction given under Section 30 of the Patents Act 1977, the application is proceeding in the name of

TECHNOLOGY VENTURES INTERNATIONAL LIMITED,
Suite D,
1 St Swithins Row,
ABERDEEN,
AB10 6DL,
United Kingdom

[ADP No. 08436750001]

Incorporated in the United Kingdom,

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31MAY02 E722783 D03312
P01/7700 0.00-0212553.2

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1. Your reference

P12213GB\AS\AJD\AM

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0212553.2 30 MAY 2002

3. Full name, address and postcode of the or of each applicant *(underline all surnames)*

TECH-21 LTD
'CAIRNLAW'
MILTON OF CULLODEN
INVERNESS
IV2 7NT
SCOTLAND
UNITED KINGDOM

SECTION 8(3) 1977 ACT) APPLICATION FILED 18/7/02

Patents ADP number *(if you know it)*

If the applicant is a corporate body, give the country/state of its incorporation

UNITED KINGDOM

4. Title of the invention

DRILLING APPARATUS

5. Name of your agent *(if you have one)*

"Address for service" in the United Kingdom to which all correspondence should be sent *(including the postcode)*

CRUIKSHANK & FAIRWEATHER
19 ROYAL EXCHANGE SQUARE
GLASGOW
G1 3AE
SCOTLAND
UNITED KINGDOM

Patents ADP number *(if you know it)*

547002

6. If you are declaring priority from one or more earlier patent applications, give the country and the date of filing of the or of each of these earlier applications and *(if you know it)* the or each application number

| Country | Priority application number *(if you know it)* | Date of filing *(day / month / year)* |
|---|---|---|

7. If this application is divided or otherwise derived from an earlier UK application, give the number and the filing date of the earlier application

| Number of earlier application | Date of filing *(day / month / year)* |
|---|---|

8. Is a statement of inventorship and of right to grant of a patent required in support of this request? *(Answer 'Yes' if:*

*a) any applicant named in part 3 is not an inventor, or*
*b) there is an inventor who is not named as an applicant, or*
*c) any named applicant is a corporate body.*
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YES

Patents Form 1/77

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| | |
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| Description | 19 |
| Claim(s) | 7 |
| Abstract | 1 |
| Drawing(s) | 3 |

10. If you are also filing any of the following, state how many against each item.

| | |
|---|---|
| Priority documents | |
| Translations of priority documents | |
| Statement of inventorship and right to grant of a patent *(Patents Form 7/77)* | |
| Request for preliminary examination and search *(Patents Form 9/77)* | |
| Request for substantive examination *(Patents Form 10/77)* | |
| Any other documents *(please specify)* | |

11. I/We request the grant of a patent on the basis of this application.

Signature [signature] Date

CRUIKSHANK & FAIRWEATHER 30 MAY 2002

12. Name and daytime telephone number of person to contact in the United Kingdom

ANDREW SHANKS
0141 221 5767

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# DRILLING APPARATUS

## FIELD OF INVENTION

The present invention relates to a drilling apparatus, and in particular to a drilling apparatus for drilling deviated bores, particularly, but not exclusively, for intersecting a subterranean hydrocarbon formation.

## BACKGROUND OF INVENTION

In the oil and gas extraction industry, hydrocarbons are extracted from a subterranean formation through bores which are drilled from surface level to intersect the formation. In many circumstances, a number of vertical bores are required for efficient and effective extraction of hydrocarbons from a single formation, which often necessitates a corresponding number of surface drilling locations, which can be undesirable, particular in offshore drilling operations. Methods, however, exist which allow non-vertical bores to be drilled permitting a wide area to be accessed from a single surface drilling location. Such methods are commonly referred to as directional or controlled trajectory drilling.

During directional drilling operations, a curved or deviated bore may be drilled by placing a slight bend in the drilling assembly, referred to as a bent sub assembly, and orientating the bend in the required direction. For example, if the bend points upwards, the well bore will gain inclination angle. Likewise, if the bend points downwards, the well will drop angle and tend to return to a vertical plane. If the bend is used to point the drill bit left or right, the well bore will change direction accordingly to the left or right.

Rotation of the drill bit is normally achieved by rotating the drill string from surface level. When a bent sub assembly is present, the rotation of the whole drill string negates the effect of the bent sub assembly.

However, it is conventional to drive the drill bit during directional drilling using a downhole positive displacement mud motor which normally comprises a long section of twisted pipe with a similarly twisted rotor positioned therein. The flow of drilling fluid through the twisted section will turn the rotor which is connected to the drill bit by a flexible steel rod which passes through the bent sub assembly. In this way, the drill bit is turned without the bent sub assembly rotating and without the

requirement for the whole drill pipe to be rotated from the surface.

However, when the bit makes contact with the rock face at the bottom of the bore, the torque generated by the mud motor has an equal and opposite reactive torque which will cause the drill string to twist or rotate back to surface level. The twist is normally significant and makes control of the angle at which the bent sub points the drill bit difficult to set and maintain.

Furthermore, when the drill string is not rotated, a situation known as "stick slip" occurs which can potentially damage the tooling. Stick slip occurs because the weight applied to a stationary drill string to advance a drill bit has to overcome static friction between the drill string and the bore wall; the non-rotating string tends to stick in the bore, such that weight or force has to be applied to move the string forward. The string will then often "unstick" suddenly, and slip forward, forcing the drill bit into the end of the bore and often stalling the mud motor. It is therefore preferred that the drill string also be rotated during all drilling operations such that a lower, dynamic friction has to be overcome, allowing for smoother drilling.

It is known to provide directional drilling while rotating the entire drill assembly ("rotary directional drilling"), however, this requires additional and sometimes complicated and expensive downhole assemblies to maintain the bent sub in its desired orientation.

During directional drilling, it is essential that the direction in which the bent sub is pointing is known at all times, to ensure that the bore is being drilled in the correct direction and that adjustment to the orientation of the bent sub may be made as soon as an error is detected. In previously proposed rotary directional drilling systems, such monitoring is commonly achieved using dedicated complex electrical systems which are provided in addition to the Measurement-While-Drilling (MWD) systems already provided within the bottom hole drilling assembly (BHA), thus increasing the complexity and expense of monitoring equipment which must be provided.

It is among the objectives of the embodiments of the present invention to provide directional drilling apparatus which obviates, or at least mitigates the aforementioned problems with the prior art.

SUMMARY OF INVENTION

According to a first aspect of the present invention, there is provided a drilling apparatus for drilling a deviated bore, said apparatus comprising:

a tubular outer member having an offset and for rotatably supporting a drill bit, the member having gripping means for selectively engaging the wall of a bore to restrain the member against rotation;

an inner member within the outer member and for coupling to the drill bit at one end and to a drill string at another end;

wherein the apparatus has a first configuration in which the gripping means is retracted and the inner member is coupled to the outer member such that rotation of the drill string provides for corresponding rotation of the inner and outer members, and a second configuration in which the gripping means is extended and the inner member is rotatable relative to the outer member such that the outer member is restrained from rotation in the bore and rotation of the drill string provides for corresponding rotation of the inner member and the drill bit.

Thus, with the apparatus in the first configuration, the offset of the outer tubular member may be rotated to a required orientation, which orientation may then be maintained by reconfiguring the apparatus such that the outer member, including the offset, is then restrained from further rotational motion. In the second configuration, the offset drill bit is rotated by the drill string, that is the offset drill bit is driven from surface, thus obviating the need to provide a separate downhole motor, and avoiding the difficulties that arise when attempting to drill without rotation of the drill string.

Conveniently, the inner member may be moved in at least one of axially and rotatably relative to the outer member to reconfigure the apparatus.

Preferably, the inner member includes an elongate drive member, such as a drive rod, which extends through at least a portion of the outer member. An upper portion of the inner member may be adapted for coupling to the drill string, with a lower portion of the inner member adapted for coupling to the drill bit, the elongate drive member rotatably coupling the upper and lower members.

Preferably, the drive member is flexible, to accommodate different relative orientations of the offset.

Preferably also, the drive member is axially moveable relative to at least one of the upper and lower members. The drive member and said at least one of the members preferably define a cooperating profile to provide rotational coupling while permitting relative axial movement. For example, the drive member may have a hexagonal section, and the upper or lower member defines a cooperating hexagonal bore.

Preferably, the inner member is coupled to the outer member by engagement of at least one pin mounted on one of the inner and outer members, with at least one complementary profiled path in the other of said inner and outer members. More preferably, the inner member is coupled to the outer member by engagement of at least one pin on the outer surface of the inner member with at least one complementary profiled path or track on an inner surface of the outer member. In a preferred embodiment, a plurality of pins are provided on the inner member which respectively engage complementary profiled paths in the outer member. Thus, by moving the inner member relative to the outer member, the at least one pin may be moved within the corresponding profiled path in order to reconfigure the drilling apparatus.

Preferably, the apparatus is arranged such that, in the first configuration, the relative rotational orientation of the inner and outer members is known. This may be achieved by any appropriate mechanism, for example when pins or followers on one member engage paths or tracks on the other member, these may be arranged such that the pins or followers will only engage with a selected track or groove. In a preferred embodiment, one of the pins or followers may be longer than the others, and only a selected one of the paths or tracks may have a lead-in which will accommodate the longer pin.

This preferred arrangement offers the advantage that, in the first configuration, the relative orientation of the outer member, and its offset, to the inner member, and thus to the drill string, and the associated bottom hole assembly (BHA), will always be the same. As the BHA conventionally includes MWD apparatus, this existing MWD apparatus may be utilised to determine the orientation of the offset. Thus, the apparatus does not require the provision of dedicated MWD apparatus, or other orientation sensors, with a considerable saving in the costs of producing, using and maintaining the apparatus.

Preferably, in a third configuration, with weight applied to the apparatus, the gripping means is retracted and the inner member is coupled to the outer member such that rotation of the drill string provides for corresponding rotation of the inner and outer members, and the drill bit. The third configuration may thus be utilised for rotary drilling with the offset rotating with the drill string and thus its directional effect negated.

Preferably, the first configuration may be attained when the apparatus is lifted off bottom.

Preferably, the second configuration is attained with weight applied to the apparatus.

Preferably, the apparatus is adapted to move between configurations sequentially, in response to the application and lifting of weight to and from the apparatus. In a preferred embodiment, the apparatus may be cycled from the first configuration, to the second configuration, to the third configuration, and then to the first configuration.

The gripping means may take any appropriate form. Preferably, the gripping means are weight actuated, that is the gripping means extend and retract in response to weight being applied to or lifted from the apparatus. The gripping

means may comprise radially movable members which engage movable cams or the like, but preferably comprise axially extending members which buckle or bow outwards on compression thereof. The members may carry ridges, teeth, or other profiles adapted to grip the bore wall to prevent rotation but to permit axial sliding. In other embodiments the gripping means may be fluid pressure actuated. Preferably, the gripping means is biassed towards the retracted position.

Preferably, the apparatus includes a bearing between the inner and outer members such that, in the second configuration, weight may be applied to the drill bit from the drill string via the inner and outer members while the inner member and drill bit rotate relative to the outer member.

The invention also relates to a method of directional drilling utilising the apparatus as described above.

Those of skill in the art will also realise that some or all of the preferred features described above may be utilised to advantage in other forms of drilling apparatus, and are not restricted to use in combination with the abovementioned first aspect of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

These and other aspects of the invention will now be described, by way of example, with reference to the accompanying drawings, in which:

Figure 1 is a schematic sectional view of drilling apparatus in accordance with a preferred embodiment of a first aspect of the present invention, shown in a first configuration;

Figure 2 shows the drilling apparatus of Figure 1 in a second configuration;

Figure 3 shows the drilling apparatus of Figure 1 in a third configuration;

Figure 4 is an enlarged perspective view of parts of an outer member and an inner member of the apparatus of Figure 1, showing tracks defined by the outer member and track following pins mounted on the inner member.

Figure 5 is an enlarged view of one of the tracks provided in the outer member of Figure 4;

Figure 6 is a sectional view on line A - A of Figure 2; and

Figure 7 is a sectional view on line B - B of Figure 2.

DETAILED DESCRIPTION OF THE DRAWINGS

Reference is first made to Figures 1 to 3 of the drawings which illustrate a drilling apparatus 10 for drilling a deviated bore, in accordance with a preferred embodiment of the present invention.

The apparatus comprises a tubular outer member 12 comprising an upper sleeve 14 defining a plurality of inner tracks 16, a tubular body 18 carrying a plurality of spring grippers 20, and a leading bent sub 22 defining an offset. Those of skill in the art will recognise that the offset is exaggerated in the Figures; in practice, the offset is typically around 1 degree. The sub 22 provides a rotatable mounting for a drill bit 24, via bearing 26. The bit 24 is rotatably coupled to the end of a flexible hexagonal drive rod 28. The drive rod 28 extends upwardly, through the bent sub 22 and body 18, and is rotatably coupled to an inner member 32, the lower end of the member 32 being located within the outer upper sleeve 14 and provided with studs 33 for engaging respective tracks 16 in the sleeve 14. The upper end of the sleeve 32 is coupled to the drill string (not shown).

In a first configuration, as illustrated in Figure 1 of the drawings, the grippers 20 are radially retracted, and in

use will describe a diameter less than the inner diameter of the bore being drilled. The outer and inner members 12, 32 are rotatably coupled, such that rotation of the drill string string from surface causes the entire apparatus 10 to rotate in unison. As will be described, the relative orientation of the coupled members 12, 32 is known, such that by monitoring the output of the MWD apparatus provided in the bottom hole assembly (BHA) of the drill string above the apparatus 10, which MWD apparatus will indicate, among other things, the orientation of the BHA, the orientation of the bent sub 22 may be determined. Thus, by rotating the string from surface, a desired and readily determined bent sub orientation may be achieved.

Once the bent sub 22 has been orientated as desired, the apparatus 10 is reconfigured, to the second configuration, as illustrated in Figure 2, to retain the selected orientation and to drill in the resulting selected direction. As will subsequently be described in greater detail, reconfiguring the apparatus 10 radially extends the grippers 20 to engage the surrounding wall, while disengaging the outer and inner members 12, 32 such that the inner member 32 may be rotated in the bore while the outer member 12 does not rotate. The orientation of the bent sub

22 is therefore retained while the drill bit 24 may be rotated from surface, via the inner member 32.

For drilling straight ahead, the apparatus 10 is arranged in a third configuration, as illustrated in Figure 3 of the drawings. In this configuration, the grippers 20 are retracted and the outer and inner members 12, 32 are rotationally coupled. Thus, rotation of the bit 24 is accompanied by rotation of the outer member 12, including the bent sub 22, such that the effect of the bent sub 22 is negated.

The construction and operation of the apparatus will now be described in greater detail, with reference also to Figures 4 to 7 of the drawings.

Reconfiguring the apparatus 10 is achieved simply by the sequential application of weight to the apparatus 10 and then lifting the bit 24 off bottom, such that a tension is applied to the apparatus 10.

Figures 4 and 5 illustrate the tracks 16 which are machined into the inner face of the upper sleeve 14, and the studs 33 which are arranged to move in an anti-clockwise direction around the tracks 16 as the apparatus is cycled between configurations. With reference to Figure 5, the

stud positions 33a, 33b and 33c correspond to the first, second and third configurations shown in Figures 1, 2 and 3, respectively.

One of the six studs 33f is longer than the others, as is visible in Figure 6 of the drawings which is a sectional view of Figure 2 through A-A . This stud 33f cooperates with a deeper cut track 16f (Figure 4) having a flared lead-in 40, such that the longer stud 33f can only be located in the deeper track. Thus, when the outer and inner members 12, 32 are rotatably coupled, the relative rotational positions of the members 12, 32 are known.

Reference is now made in particular to Figure 7 of the drawings, which is a sectional view through B-B of Figure 2 showing the spring grippers 20 in their extended configuration, extending radially beyond gripper locating slots 42 in the body 18. The grippers 20 are in the form of axially extending rectangular bands and each carries an axial ridge 44 to grip the bore wall to prevent rotation while permitting axial movement. From Figure 2 it will be noted that the lower end of each gripper 20 is retained in a slot 46 in the body 18, while the upper end of each gripper 20 is attached too a bearing race 48 located between the

upper end of the body 18 and the lower end of upper sleeve 14.

When the apparatus 10 is in the second configuration, the lower end of the inner member 32 contacts and moves the bearing race 48 down towards the upper end of the body 18, causing the grippers 20 to bow outwards to engage and grip the bore wall. In the first and third positions, the bearing race 48 is free to move upwards under the return force of the gripper bands 20.

For normal drilling of a bore straight ahead, the apparatus 10 is maintained in the second configuration (Figure 2), with the studs 33 in the position 33b (Figure 5). Weight applied from surface, or from the mass of the drill string above the apparatus, is transmitted to the bit 24 from the inner member 32 to the outer sleeve 14 via the studs 33, and through the body 18 and the bent sub 22.

The inner member 32 is prevented from coming into contact with the bearing race 48 as axial movement of the member 32 is restrained by the studs 33 engaging with the tracks 16, such that the grippers 20 remain retracted. Thus, the apparatus 10 rotates as one with the drill string, the rotation of the bent sub 22 negating the effect of the offset.

If it is desired to deviate the bore in a particular direction, rotation of the string is stopped, and the string lifted from bottom, such that studs 33 travel up the respective tracks 16 to position 33a (Figure 5), the inner member 32 sliding upwardly over the drive rod 28. The apparatus 10 is now in the first configuration as shown in Figure 1. The inner member 32 remains rotatably coupled to the outer sleeve 14, such that rotation of the string causes the apparatus, including the bent sub 22, to rotate in the bore.

By monitoring the MWD of the BHA, the bent sub 22 may be postponed in a desired orientation, to achieve the desired deviation of the bore.

If weight is then applied to the apparatus 10, the studs 33 move down the tracks 16 beyond the lower ends of the tracks 16, to position 33b, such that the apparatus is in the second configuration (Figure 2).

In this configuration, the studs 33 are clear of the tracks 16 and thus the inner member 32 may rotate without causing corresponding rotation of the outer sleeve 14, drive rod 28 transferring rotation from the member 32 to the drill bit 24. The lower end of the inner member 32 engages the bearing race 48, causing the grippers 20 to buckle outwardly

into contact with the bore wall, preventing the outer member 12 from rotating.

Thus, in this configuration, when the drill string is rotated, the outer member 12 does not rotate, while the bit 24 is rotated and advances the bore in the direction of selected orientation of the bent sub 22.

When the orientation of the BHA, and thus the bore, as measured by the MWD apparatus, has changed to that desired by the driller, rotation of the drill string is halted. The drill string is then lifted, and then weight applied once more to locate the studs 33 in the position 33c. The bore may then be drilled on, maintained to previously attained bore orientation.

It will thus be appreciated that the apparatus 10 provides a relatively simple and robust arrangement for permitting rotary directional drilling.

It will of course be appreciated by those of skill in the art that the above described example is merely exemplary of the present invention, and that various modifications and improvements may be made thereto, without departing from the scope of the invention. For example, the drive rod 28 may be hollow, to allow objects and tools, such as logging

tools, to be run in through the apparatus. In certain embodiments, such a hollow drive rod may be utilised together with a drill bit having a removable portion, to permit "through-the-bit-logging". Such an arrangement is described in US Patent No. US 6,269,891 which relates to a system and method of drilling and logging an earth formation.

CLAIMS:

1. A drilling apparatus for drilling a deviated bore, said apparatus comprising:

a tubular outer member having an offset and for rotatably supporting a drill bit, the member having gripping means for selectively engaging the wall of a bore to restrain the member against rotation;

an inner member within the outer member and for coupling to the drill bit at one end and to a drill string at another end;

wherein the apparatus has a first configuration in which the gripping means is retracted and the inner member is coupled to the outer member such that rotation of the drill string provides for corresponding rotation of the inner and outer members, and a second configuration in which the gripping means is extended and the inner member is rotatable relative to the outer member such that the outer member is restrained from rotation in the bore and rotation of the drill string provides for corresponding rotation of the inner member and the drill bit.

2. A drilling apparatus as claimed in claim 1, wherein the inner member is at least one of axially moveable and

rotatably moveable relative to the outer member, to reconfigure the apparatus.

3. A drilling apparatus as claimed in claim 1 or 2, wherein the inner member includes an elongate drive member which extends through at least a portion of the outer member.

4. A drilling apparatus as claimed in claim 3, wherein the elongate drive member is a drive rod.

5. A drilling apparatus as claimed in claim 3 or 4, wherein an upper portion of the inner member is adapted for coupling to the drill string, with a lower portion of the inner member adapted for coupling to the drill bit, the elongate drive member rotatably coupling the upper and lower portions.

6. A drilling apparatus as claimed in claim 3, 4 or 5, wherein the drive member is flexible, to accommodate different relative orientations of the offset.

7. A drilling apparatus as claimed in any one of claims 3 to 6, wherein the drive member is axially moveable relative to at least one of the upper and lower portions.

8. A drilling apparatus as claimed in any one of claims 3 to 7, wherein the drive member and at least one of the upper and lower portions define a cooperating profile to provide

rotational coupling while permitting relative axial movement.

9. A drilling apparatus as claimed in claim 8, wherein the drive member has a hexagonal section, and the upper or lower portion defines a cooperating hexagonal bore.

10. A drilling apparatus as claimed in any preceding claim, wherein the inner member is coupled to the outer member by engagement of at least one pin mounted on one of the inner and outer members, with at least one complementary profiled track in the other of said inner and outer members.

11. A drilling apparatus as claimed in any preceding claim, wherein the inner member is coupled to the outer member by engagement of at least one pin on the outer surface of the inner member with at least one complementary profiled track on an inner surface of the outer member.

12. A drilling apparatus as claimed in claim 11, wherein a plurality of pins are provided on the inner member which respectively engage complementary profiled tracks in the outer member.

13. A drilling apparatus as claimed in any preceding claim, wherein the apparatus is arranged such that, in the first configuration, the relative rotational orientation of the inner and outer members is predetermined.

14. A drilling apparatus as claimed in claim 10, 11, 12 or 13, wherein when pins on one member engage profiled tracks on the other member, the pins and profiled tracks being arranged such that the pins will only engage with a selected respective profiled track.

15. A drilling apparatus as claimed in any one of claims 10 to 14, wherein one of the pins is longer than the others, and only a selected one of the profiled tracks has a lead-in which will accommodate the longer pin.

16. A drilling apparatus as claimed in any preceding claim, wherein the apparatus has a third configuration, in which third configuration, with weight applied to the apparatus, the gripping means is retracted and the inner member is coupled to the outer member such that rotation of the drill string provides for corresponding rotation of the inner and outer members, and the drill bit.

17. A drilling apparatus as claimed in claim 16, wherein the apparatus in a third configuration may be utilised for rotary drilling with the offset rotating with the drill string and thus its directional effect negated.

18. A drilling apparatus as claimed in any preceding claim, wherein the first configuration may be attained when the apparatus is lifted off bottom.

19. A drilling apparatus as claimed in any preceding claim, wherein the second configuration is attained with weight applied to the apparatus.

20. A drilling apparatus as claimed in any preceding claim, wherein the apparatus is adapted to move between configurations sequentially, in response to the application and lifting of weight to and from the apparatus.

21. A drilling apparatus as claimed in claim 20 when dependent on claim 16 or 17, wherein the apparatus is cycled from the first configuration, to the second configuration, to the third configuration, and then to the first configuration.

22. A drilling apparatus as claimed in any preceding claim, wherein the gripping means are weight actuated such that the gripping means is extended and retracted in response to weight being applied to or lifted from the apparatus.

23. A drilling apparatus as claimed in any of the preceding claims, wherein the gripping means comprises axially

extending members which buckle outwards on compression thereof.

24. A drilling apparatus as claimed in claim 23, wherein the members carry profiles adapted to grip the bore wall to prevent rotation but to permit axial sliding.

25. A drilling apparatus as claimed in claim 24, wherein the profiles are ridges.

26. A drilling apparatus as claimed in any preceding claim, wherein the gripping means is biased towards the retracted position.

27. A drilling apparatus as claimed in any preceding claim, wherein the apparatus includes a bearing between the inner and outer members such that, in the second configuration, weight may be applied to the drill bit from the drill string via the inner and outer members while the inner member and drill bit rotate relative to the outer member.

28. A drilling apparatus as claimed in any preceding claim, wherein the inner member is hollow.

29. A drilling apparatus as claimed in claim 28, in combination with a logging tool adapted to be run-in through the inner member.

30. A drilling apparatus substantially as described herein and as shown in the accompanying representations.

31. A method of directional drilling utilising the apparatus as described in any preceding claim.

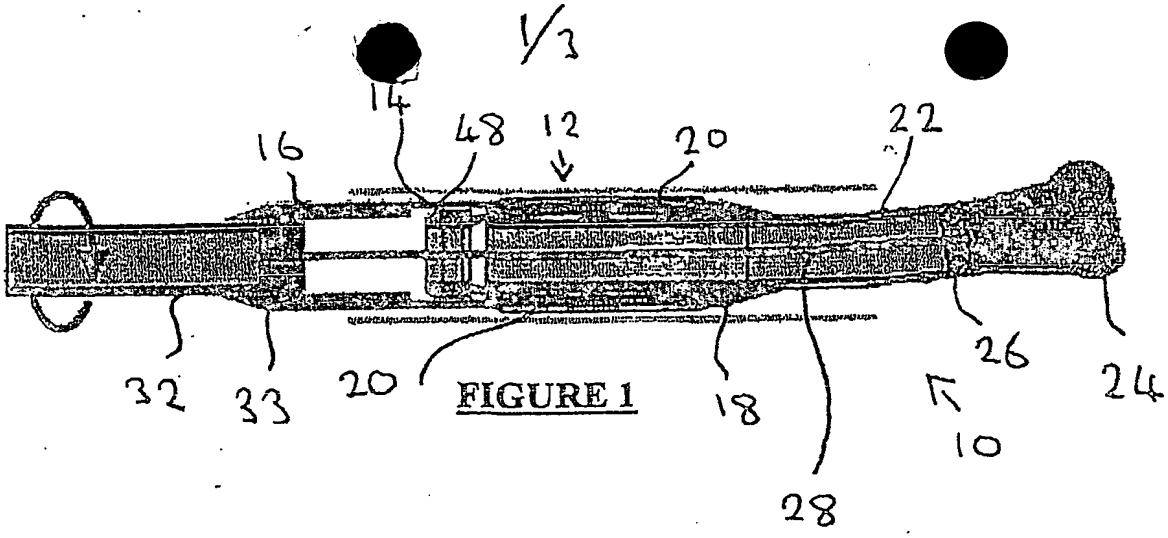


FIGURE 1

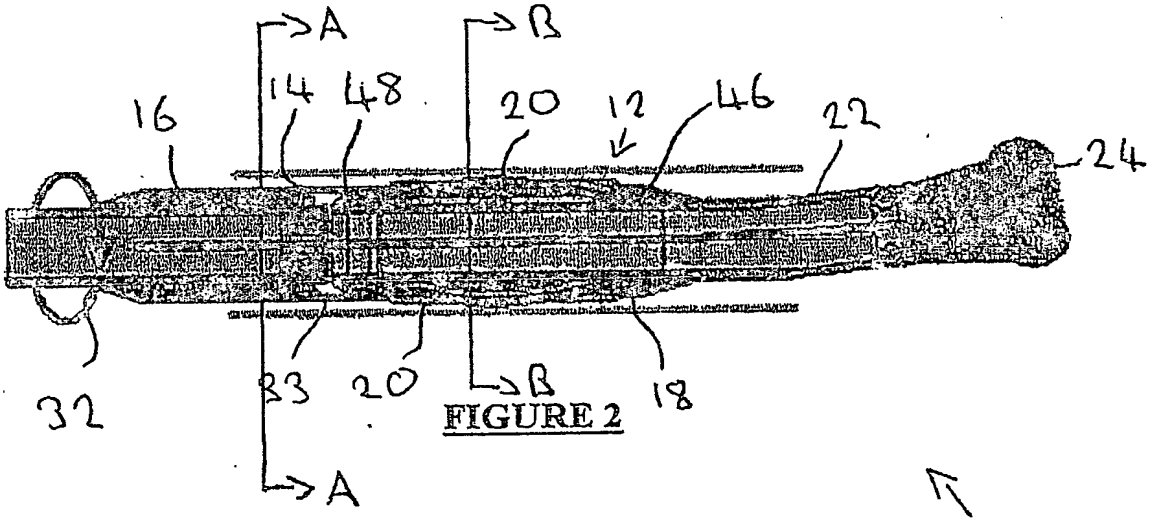


FIGURE 2

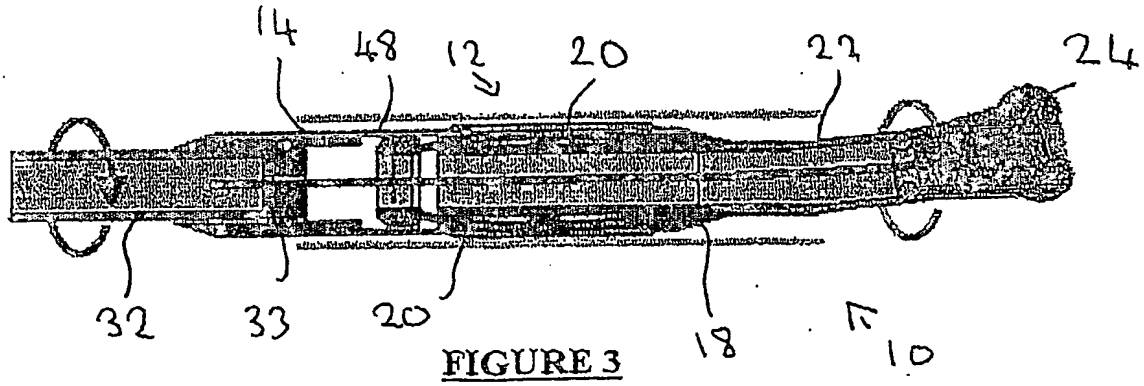


FIGURE 3

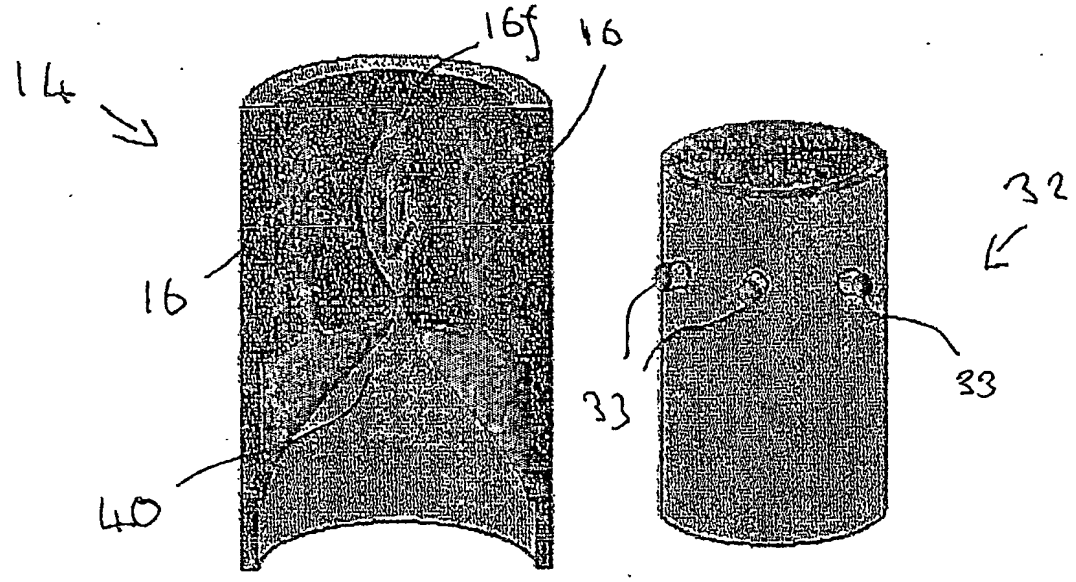


**FIGURE 4**

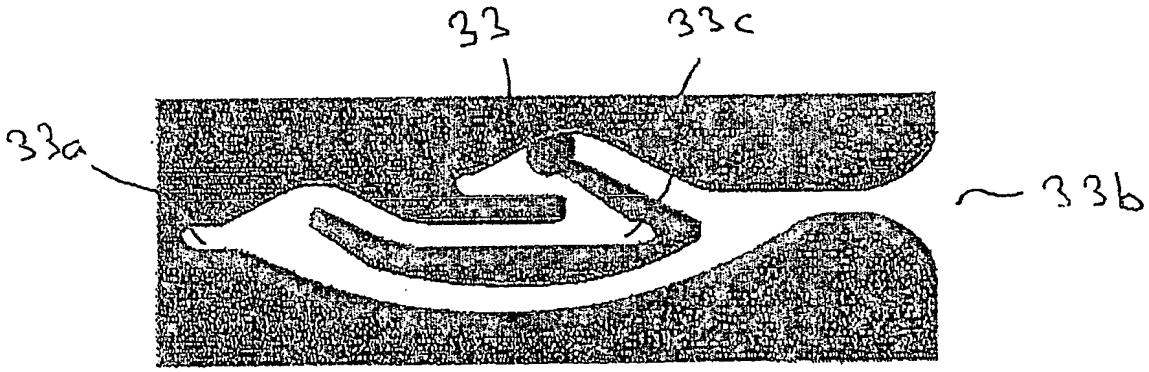


**FIGURE 5**

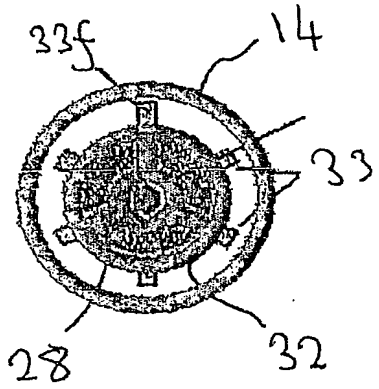


**FIGURE 6**

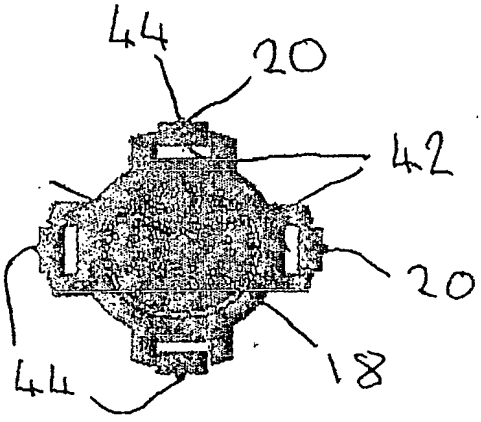


**FIGURE 7**

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